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Insect Pests of the PEACH

in the EASTERN STATES

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THE PLUM CURCULIO, the peach borer, the San Jose scale, and the oriental fruit moth are responsible for much of the damage caused by insects in peach orchards in the eastern half of the United States. This bulletin contains brief descriptions of these and certain other insects and their work and presents available information on methods for controlling them.

Experience has shown that much of the loss caused by insect attacks in peach orchards can be prevented by the thorough and timely application of the control measures outlined herein.

This bulletin is based largely upon Farmers' Bulletin No. 1557, Insects Attacking the Peach in the South and How to Control Them, and supersedes that bulletin. Its scope has been broadened, however, to apply to conditions existing in most of the peach-growing regions east of the Rocky Mountains.

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INSECT PESTS OF THE PEACH IN THE EASTERN STATES

see 16.636

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E.M.N.

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THE PEACH is attacked by many different insects. Among the most important of these are the plum curculio, the peach borer, the San Jose scale, and the oriental fruit moth. In the peach-growing regions of the United States east of the Rocky Mountains these four pests are responsible for much of the insect damage that occurs. This bulletin gives a brief discussion of the biology and methods of control of each of these, as well as of several other kinds of insects that may at times cause serious damage in restricted sections. If the reader encounters problems in insect control on peaches that are not dealt with in this publication, he should take the matter up with his county agricultural agent, or write to his State agricultural experiment station, the extension service of his State college of agriculture, his State entomologist, or the United States Department of Agriculture. Much more definite information can be given if specimens of the injury and the insects causing it are furnished. (Live insects should not be sent. The insects should be killed and forwarded dry or preserved in alcohol or formalin.)

THE PLUM CURCULIO

The plum curculio (*Conotrachelus nenuphar* (Hbst.)), or peach worm, as it is frequently called by peach growers, is the most serious insect pest that directly attacks the peach fruit in the eastern part of the United States. The adult females injure the fruit by puncturing it for egg laying, and the result is a wormy peach (fig. 1); in addition, the adults of both sexes cause gnarly fruit by making punctures for feeding (fig. 2). When control measures are not used, sometimes over half the peaches are wormy or are gnarled from feeding punctures. Not only does the curculio damage the peach directly, but the rupture of the skin for feeding or egg laying furnishes a place for the brown rot fungus to enter. Many infections of brown rot (caused by *Sclerotinia fructicola* (Winter) Rehm.) in peaches start in this manner.

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The plum curculio is a native American insect and is widely distributed east of the Rocky Mountains, being especially abundant as a peach pest in the Southern States. It is not known to occur west of the Rocky Mountains.

DESCRIPTION, LIFE HISTORY, AND HABITS

The adult insect is a hard snout beetle, about three-sixteenths of an inch in length, brown, mottled with gray. (See cover-page illustration.) The egg of the curculio is whitish and rather elliptical, with a smooth, shiny surface. The full-grown larva, or grub, is about three-eighths of an inch in length and is yellowish white, with a brown head (fig. 1).

FIGURE 1.—Small peach cut open, showing curculio larva and its work.

The insect passes the winter as an adult under leaves, grass, bark, sticks, and rubbish in woodlands adjacent to and near peach orchards and under grass and trash in the orchard or along terrace rows and fences. Bermuda grass and Johnson grass perhaps furnish the best hibernating quarters in southern peach orchards. The beetles usually begin to leave hibernation in the South before full bloom of the peach and are in the orchards in numbers by the time the trees are in full bloom. In the North the first beetles usually appear later, with reference to the blooming period, than in southern orchards.

In the South the beetles immediately begin feeding on the blooms, particularly the calyxes or outer flower parts, and to some extent on the unfolding leaves. As soon as the calyx splits, the females begin to deposit their eggs in small cavities just under the skin of the small peaches. Here the eggs hatch in from 2 to 12 days, depending on weather conditions, and the small larvae, grubs, or "worms," begin to feed on the flesh of the peach, in most cases boring into it until the pit is reached.

Most of the small peaches that are punctured by the curculio early in the season fall to the ground within a few weeks after the calyxes, or "shucks," have been pushed off. The worms remain in the peaches, however, and after a total feeding period of 2 weeks or

more reach maturity, make their way out of the fruit, and enter the soil to transform into adult beetles. This transformation takes place in a soil cell, constructed within 2 or 3 inches of the surface. The time spent in the soil as larva (in preparing the cell), pupa, and adult (before emerging) is from 30 to 35 days. In all, from 50 to 55 days is required, on an average, for the curculio to complete its life cycle from the laying of the egg to the emergence of the adult.

Two generations of the plum curculio often occur in southern peach orchards in a season. The injury done by the second generation is most serious when an early spring causes the overwintering adults to leave hibernation before the normal time and when favorable climatic conditions shorten the time that the insect spends in the soil for pupation. When the beetle is kept in hibernation by cold weather until April or when a cold April or May retards pupation, only one generation can mature. When two generations mature, the varieties of peaches ripening before the Hiley are not subjected to the second brood of larvae. The Hiley usually escapes injury, although the last few pickings may show the presence of tiny second-brood curculio larvae; but the Belle and Elberta are attacked by second-brood grubs. Second-brood adults emerge from the soil during August.

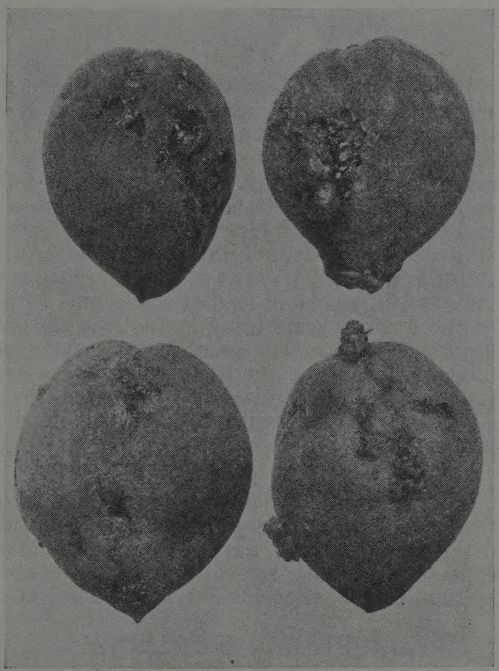

FIGURE 2.—Peaches gnarled as a result of the egg-laying and feeding activities of the plum curculio.

In northern peach orchards only one generation of the plum curculio occurs each year. In an intermediate area, in the latitude of Delaware to Virginia, a partial second generation occasionally develops.

CONTROL MEASURES FOR THE PLUM CURCULIO

Spraying

Spraying with lead arsenate, when thoroughly done at the right times, has been found to give adequate protection from the curculio in all but the most severe infestations. The details of the program to be followed depend on the seasonal history of the insect in the

particular locality. In the South the curculios usually reach the trees in numbers by the time of full bloom and feed on the calyxes, or outer flower parts. In that region it has been found that an application of lead arsenate when 75 percent of the petals are down will kill many of the beetles before egg laying begins. As a weapon against a second brood of grubs in the South and to prevent surviving adults of the preceding winter from ovipositing heavily during the ripening period of the fruit, lead arsenate should always be used on each variety 4 weeks before that particular variety is due to ripen.

Dusting

Dust is not so effective against the curculio as spray; and growers are advised to use liquid in preference to dust, especially if sufficient spraying equipment is available to cover the acreage in from 3 to 5 days. The time for making applications of dust is the same as that given in the spraying schedules which follow. For the first two applications the dust should contain from 5 percent of lead arsenate and 95 percent of hydrated lime to 10 percent of lead arsenate and 90 percent of hydrated lime; and for later applications, 80 percent of sulfur and from 5 percent of lead arsenate and 15 percent of hydrated lime to 10 percent of lead arsenate and 10 percent of hydrated lime; or the formula containing sulfur may be used for all applications if desired. The percentage of lead arsenate used in the dust varies in different localities, but the results of the experiments carried on by the author in Georgia have indicated that the degree of curculio control is as great with 5 percent of lead arsenate as with higher proportions.

Spraying Programs

The following general spray programs [1] are included to aid the reader in developing a program for his particular orchard. For more detailed information, applicable to local conditions, the reader should consult his county agricultural agent, State agricultural experiment station, or the extension service of his State college of agriculture.

TABLE 1.—*Summer spray program usually followed in southern peach orchards*

Application	Time	Material per 100 gallons of water	Disease or insect controlled	Remarks
First	When 75 percent of the petals have fallen.	Lead arsenate, 2 pounds; hydrated lime, 8 pounds.	Plum curculio.	
Second	When calyxes are being shed (usually 10 days after first application).	Same as first application	do	For early varieties a sulfur fungicide, such as those listed for the third application, should be included for control of brown rot and scab.
Third	2 weeks after second application.	Wettable sulfur [a] (as recommended on label by manufacturer) or self-boiled lime-sulfur (sulfur, 16 pounds; stone lime, 16 pounds).	Brown rot [a] and scab.	On early varieties this application may be omitted if the preceding application has included the sulfur fungicide.
Fourth	4 weeks before the variety is due to be harvested.	Lead arsenate, 2 pounds; wettable sulfur (as recommended on label by manufacturer) or self-boiled lime-sulfur (sulfur, 16 pounds; stone lime, 16 pounds).	Plum curculio and brown rot.	

[a] More specific information on the control of brown rot and scab and on the sulfur fungicides used for their control can be obtained from Farmers' Bulletin 1527, Peach Brown Rot and Scab.

[1] The information relating to disease control was furnished by John W. Roberts, principal pathologist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry.

TABLE 2.—*Summer spray program usually followed in northern peach orchards*

Application	Time	Material per 100 gallons of water	Disease or insect controlled	Remarks
First	When calyxes are being shed (usually about 10 days after the petals have fallen).	Lead arsenate, 2 pounds; hydrated lime, 8 pounds.	Plum curculio.	
Second	2 weeks after first application.	Lead arsenate, 2 pounds; wettable sulfur [1] (as recommended on the label by the manufacturer) or self-boiled lime-sulfur (sulfur, 16 pounds; stone lime, 16 pounds).	Plum curculio, brown rot, and scab.[1]	In areas in which curculio infestation is very light, lead arsenate is sometimes omitted.
Third	1 month before variety is due to ripen.	Wettable sulfur (as recommended on the label by the manufacturer) or self-boiled lime-sulfur (sulfur, 16 pounds; stone lime, 16 pounds).	Brown rot.	In areas in which the curculio is especially difficult to control, lead arsenate is sometimes included in this application.

[1] More specific information on the control of brown rot and scab and on the sulfur fungicides used for their control can be obtained from Farmers' Bulletin 1527, Peach Brown Rot and Scab.

Further applications of fungicides (without lead arsenate) are often made to protect the fruit from brown rot. This is especially true with varieties maturing later than Elberta. An additional application of dust (sulfur 100 percent or sulfur 80 percent and hydrated lime 20 percent) or a light application of spray that contains one of the commercial substitutes for self-boiled lime-sulfur with little or no lime may be made just before the fruit is picked. This application may be of use in preventing brown rot on the fruit, both when it is on the tree and after it is picked, especially during a wet season. The dusting should be very lightly done so as to avoid residues on the picked fruit. If only a light application is made, the weather and the ordinary handling of the fruit should remove all noticeable traces of the dust or spray.

Avoid Spray Residue

No fruit showing noticeable residues of spray or dust should be offered for sale, no matter how harmless the residues may be. It is very important that no lead arsenate be applied later than 4 weeks before the probable ripening date of each variety. Later applications of poison or a greater number of applications of lead arsenate than are recommended may result in excessive poisonous residues on the fruit at harvest time.

If, in spite of these precautions, spray residue is in evidence when the peaches are harvested, it may be satisfactorily removed by running the fruit through a brushing machine. Equipment of this type is available in most modern packing houses.

Supplementary Control Measures

Although spraying with lead arsenate is the most effective single control measure available, it is not always adequate when unusually severe infestations develop. In such circumstances other control measures must supplement the arsenical treatments if a large cull pile of wormy peaches at harvest time is to be avoided.

Jarring

It is possible to collect many beetles in the spring by placing two large sheets under the peach trees and jarring the trees with a padded pole (fig. 3). Some growers have found this control measure very profitable, especially for trees near woodlands or other hibernating places where the beetles concentrate just after leaving hibernation in the spring. When the beetles are disturbed by the jarring, they fold their legs and fall immediately to the sheets, from which they can be

FIGURE 3.—Jarring peach trees to capture adult curculios.

collected or swept into a bucket of petroleum. The beetles are less active early in the morning than at any other time, and jarring is then most effective.

Collecting Drops

The most effective supplementary control measure in areas in which two broods occur is the collection and destruction of peach drops. Since a majority of the small peaches that are punctured early in the season by the curculio fall to the ground, the collection and destruction of drops prevents the development of many adult beetles (which otherwise would cause wormy peaches at harvest) and also leaves fewer beetles in the orchard after harvest to hibernate and attack the crop the succeeding year. About 90 percent of the worms that fall to the ground in peaches during the season can be destroyed if a first collection is made about 1 month after full bloom, or when enough drops to warrant a collection are down, and two others at intervals of 5 or 6 days. As soon as they are collected, all drops should be made harmless by being placed in sacks and submerged in water or put in boiling water.

Disking Under Trees

Another supplementary control measure which fits in well with the usual orchard-management program is disking under the spread of the trees to destroy curculio pupae in the soil. If the soil cells

constructed by the larvae are broken after they have changed to helpless, delicate pupae, the heat and pressure of the soil will kill many of them, and many others will be killed by exposure to the elements and to predacious enemies. The disking should be done weekly to a depth of several inches from about May 10 until the last of June in Georgia, and during later periods north of that State.

Eliminating Places of Hibernation

Since many curculios pass the winter as adult beetles in woodland and similar cover adjacent to and near peach orchards, the burning over of such places during the winter months undoubtedly destroys many, and is a valuable supplementary control measure wherever the curculio has been particularly troublesome. As most of the insects hibernate within 100 yards of the orchard, the wooded areas need not be burned beyond that distance, and great care should be taken to control the fire and prevent injury to young forest growth. Vegetation on terrace rows and along ditchbanks and fences in and near the orchard should also be burned or grubbed out. Prunings, rubbish, and brush piles should not be allowed to remain in the orchard.

THE PEACH BORER

The peach borer (*Sanninoidea exitiosa* (Say)) every year directly or indirectly causes the death of many peach trees of all ages in both home and commercial orchards. Although chiefly a pest of the peach, it sometimes does serious damage to cultivated plum trees and has been found breeding in wild plum. The injury is done by the larvae, which feed on the cambium or growing tissues and inner bark of the tree (fig. 4), usually on the trunk just below the surface of the soil, although the larger roots are occasionally attacked. Young trees are sometimes completely girdled by the insect; and, although older trees are less likely to be completely girdled, they are often so severely injured that their vitality is lowered and their resistance to other insects and diseases is reduced. The work of borers is usually indicated by the presence of a mass of gum, particles of bark, and frass at the base of the tree (fig. 5).

DESCRIPTION, LIFE HISTORY, AND HABITS

The adult of the peach borer is a clearwing moth. The female (fig. 6, *B*) is dark steel blue, with one or two orange bands around the abdomen. The forewings are opaque, while the hindwings are clear except for the margins. The male (fig. 6, *A*) is a little smaller, more slender, and a lighter steel blue than the female and has several narrow yellow bands around the abdomen. In the male both sets of wings are clear. The larva, or borer, when full-grown is about 1 inch long, is yellowish white or cream-colored, and has a dark-brown head.

The winter is passed in the larval, or borer, stage. Some of the younger larvae live in a more or less dormant condition throughout the winter in a covering constructed on the bark of the tree outside the burrow, whereas all the larger ones pass the winter within their burrows in the bark of the tree and feed to some extent during warm periods. Upon maturity, the larvae change to pupae in silken capsulelike cocoons into which have been woven particles of bark and

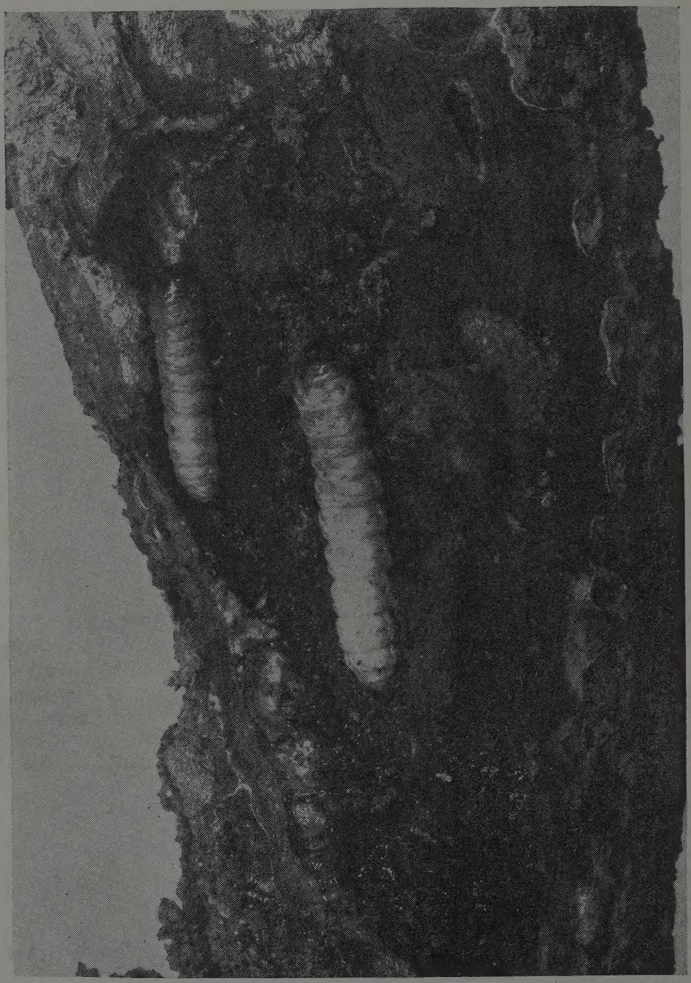

FIGURE 4.—Peach borers in the trunk of a young peach tree. (Bark and gum have been cleared away.) About twice natural size.

excrement, which give the cocoons a brownish color. They are usually near the surface of the soil, either at the head of the borer gallery or in the soil close to the tree trunk.

The pupa becomes fully matured in from 3 to 4 weeks. It then works its way out of the cocoon, and the adult moth emerges from the pupal shell. In the southern part of the Gulf States a few moths appear as early as May or June, but the heaviest moth emergence in the South occurs during August and September. Egg laying, which

usually lasts only a few days, begins shortly after the moth emerges. A female moth usually deposits from 500 to 600 eggs, mostly on the tree trunk, although some are placed on the limbs and leaves and even on weeds and soil near the tree. The length of the incubation period depends on weather conditions; the eggs hatch in 9 or 10 days in the summer.

Upon hatching, the little larvae crawl or fall to the lower part of the tree trunk and usually enter it at the surface of the soil. They may bore directly into the bark or enter a crack in the trunk. Once inside, they feed rapidly on the bark layers and cambium of the tree and, with favorable feeding conditions, attain considerable size within a few weeks. With unimportant exceptions, there is only one generation annually.

FIGURE 5.—Peach tree attacked at the base by the peach borer.

CONTROL OF THE PEACH BORER

Three methods of controlling the peach borer will be discussed. Two of these involve treatment with chemicals; the third is worming, or removing the borers by hand.

The Paradichlorobenzene Treatment

For more than 20 years paradichlorobenzene has been effectively used for peach borer control. This white, crystalline chemical, often referred to as "para" or "PDB," vaporizes slowly at ordinary temperature, and the vapor is heavier than air. The higher the temperature and the drier the soil, the more rapid is the generation of the gas from the crystals and its diffusion through the soil.

When to Apply Paradichlorobenzene

Experimentation has shown that best results with paradichlorobenzene for peach borer control are obtained by applying it in the fall at the end of the egg-laying period. At that time the borers are small and more easily killed by the gas. The material should not be applied earlier on account of the possibility of an infestation becoming established later; on the other hand, the application should

FIGURE 6.—Peach borer adults: *A*, Male; *B*, female. Two and one-half times natural size.

not be delayed too long because very little volatilization of the chemical takes place after the soil temperature drops below 60° F. The desired results cannot be expected unless the material is applied on or very close to the dates recommended in the following schedule: [2]

Michigan, New York, and the New England States	Aug. 25 to Sept. 10.
Southern lake region, New Jersey, Pennsylvania	Sept. 15 to 25.
Ozark region, Ohio Valley, Maryland, Virginia, Delaware	Sept. 25 to Oct. 5.
Northern Georgia, the Carolinas, Tennessee	Oct. 5 to 15.
Central Georgia	Oct. 20 to 25.
Southern Georgia	Oct. 25 to 30.

[2] Exact information on the best time for treatment in various localities may be obtained from the reader's State agricultural experiment station, State extension service, or local agricultural authorities.

Spring applications of the chemical give fairly satisfactory kills, although they allow the borers to feed in the trees until many are nearly grown and have done most of their damage. If it is desirable to apply a spring treatment, it should be given as soon as the ground begins to warm, the exact time depending on the locality.

Preparing the Soil

No preparation of the soil is necessary except to smooth the surface for about a foot from the tree trunk (fig. 7, *A*) with the back of a shovel before the chemical is applied. No soil should be removed, and the trees should not be mounded before the treatment unless borers are working in the tree trunk above the soil level. As the gas from the chemical is heavier than air, any borers working in the tree above the point where the ring of crystals is placed will not be affected. Consequently it is necessary to place the crystals at least at the level of the topmost borer gallery. Should there be indications of borers working in the tree trunk just above the soil level, sufficient soil should be placed around the tree to bring its level up above the gummy exudation before the chemical is applied.

How to Apply Paradichlorobenzene

Paradichlorobenzene should be applied in a continuous band about 1 or 1½ inches wide around the tree, and about 1 or 1½ inches from the trunk (fig. 7, *B*). Handy containers for applying paradichlorobenzene, holding exactly 1 ounce, can be obtained from insecticide dealers. The crystals should not be placed against the tree or too far from it. For trees of average size 6 years of age and older, 1 ounce by weight should be used per tree; for unusually large trees, an ounce and a half or more is sometimes needed; for trees 4 and 5 years old, three-fourths of an ounce is sufficient; and if trees from 1 to 3 years of age are to be treated, from one-fourth to one-half ounce should be used. After the chemical is in place, several shovelfuls of soil free from stones, sticks, and trash should be placed over it in the form of a low cone-shaped mound and packed with the back of a shovel (fig. 7, *C*). This mound serves to hold the gas and to prevent surface washing of the crystals. The packing of the soil after it is placed on the chemical is important to prevent surface loss of the gas. When the crystals are being covered, care should be taken to avoid pushing them against the tree trunk with the first shovelful of soil.

When paradichlorobenzene has been used around peach trees 4 or 5 years old, growers are advised to remove the mounds about 4 weeks after applying the chemical so that all unspent crystals will be away from the tree trunks and the confined gas will escape. It is also advisable to tear down the mounds 6 weeks after making the application to trees 6 years of age and older. If the soil is removed from below the original soil level in tearing down the mounds, it should be replaced before cold weather sets in.

Late in the spring or early in the summer it is well to level off the mounds remaining from the previous season's treatment, if this has not been done earlier. This prevents the new generation of borers from entering the trees high up on the trunk, where it would be impractical to make subsequent applications of paradichlorobenzene.

FIGURE 7.—Steps in the correct method for treating trees with paradichlorobenzene: *A*, The soil around this peach tree has been made ready for treatment; *B*, the ring of crystals should be from 1 to 1½ inches wide and from 1 to 1½ inches from the tree trunk; *C*, several shovelfuls of soil should be placed on top of the ring of crystals and packed gently with the back of a shovel.

Injury From the Chemical

Under certain conditions paradichlorobenzene may cause injury to peach trees. Damage of this kind has been particularly serious on trees from 1 to 3 years old in the southeastern part of the country. Trees 4 years of age and older have sometimes suffered slight injury, but this has rarely proved serious. The paradichlorobenzene treatment has caused serious injury to peach trees in the nursery and is therefore not recommended for nursery stock.

The Ethylene Dichloride Treatment

Ethylene dichloride, a colorless liquid with an odor like that of chloroform, has been found very effective against the peach borer and has the advantage of being comparatively safe on young trees when applied at the proper strength. It can be used in colder weather than paradichlorobenzene and is easier to apply. Stock emulsions of this material may be obtained from insecticide manufacturers or dealers, or they may be prepared on the farm in accordance with the directions given on page 33 where a more detailed discussion of this chemical will be found.

Dilution and Dosage

Table 3 gives the quantity of water to be added to a 50-percent stock emulsion of ethylene dichloride to get 10 gallons of diluted emulsions of the different strengths and the dosages found by experiment to be most satisfactory for use on peach trees of various ages.

TABLE 3.—*Dilution of stock emulsion of ethylene dichloride, strength of diluted emulsion, and quantity to be applied to trees of different ages for the control of the peach borer*

Age of trees (years)	Quantity of water and of stock emulsion to use to get 10 gallons of diluted emulsion at the proper strength		Strength of the diluted emulsion	Quantity of the diluted emulsion for each tree
	Water	50-percent stock emulsion		
	Gallons	*Gallons*	*Percent*	*Pint*
4 (and older) [1]	6	4	20	½
3	7	3	15	½
2	7	3	15	¼
1	8½	1½	7½	⅛

[1] Unusually large, older trees may require a little more than half a pint of the emulsion.

When and How to Apply the Emulsion

Ethylene dichloride emulsion may be applied for the control of the peach borer at any time during the fall or spring, and in the South applications made in warm periods during the winter give good control. Best results probably are obtained in the fall at the end of the egg-laying period of the peach borer moths, when most of the borers are small. The use of the material in extremely hot weather should be avoided, since injury to the tree is more likely to occur at high temperatures.

No preparation of the soil before treatment is necessary on loose, level ground. In some cases, however, cupping the soil slightly toward the tree trunk to prevent the liquid from running off, or loosening the soil around the tree sufficiently to permit the liquid to be readily absorbed gives better results. Any cracks in the ground around or extending out from the tree trunk should be filled with soil before treatment, to avoid undue concentration of the material on any part of the root system, which might thus be injured.

The material is applied, either by pouring or spraying it on the soil around the base of the tree in such a way that the soil will absorb and

FIGURE 8.—Applying ethylene-dichloride emulsion by pouring. A household measuring cup with a short handle is being used.

hold it around the tree at the ground line. It should not be poured or sprayed on the trunk.

The quantity applied should be regulated rather closely, since applications much in excess of the suggested dosage may cause tree injury. A tin household measuring cup holding one-half pint, with marks for one-eighth and one-fourth pint, will be found useful for applying the emulsion (fig. 8). A bucket pump may be employed for applying the ethylene dichloride, and with a little practice the quantity delivered to each tree can be regulated without difficulty. A power sprayer equipped with a device for regulating the quantity applied may also be used for this purpose. The stock emulsion should be thoroughly stirred before any is taken from the container for dilution, and the diluted emulsion should likewise be agitated before each

dose is withdrawn for use around the tree. Each bucket of diluted emulsion should be provided with a paddle for agitation in cases where the application is made by pouring. Broken-down emulsions should not be applied, as the portion consisting chiefly of ethylene dichloride may cause serious injury to the tree.

After the chemical has been applied, several shovelfuls of soil should be placed against the tree to prevent evaporation from the surface (fig. 9). The treatment needs no further attention.

Worming

For many years peach growers wormed their trees to protect them from the peach borer. If carefully done, worming keeps the insect in check reasonable well, but it cannot be classed as a very desirable control measure. Borers are often missed, and the injury to the tree from worming instruments may be more severe than that from the insect.

In preparation for worming, the soil is removed from the base of the tree to a depth of 6 or 8 inches. The borers are then removed with a sharp hawk-billed knife. The incisions should be made vertically, if possible, and care should be exercised not to injure or cut any more of the sound wood than is actually necessary in removing the borers or crushing them in their burrows. After the tree has been wormed, the soil should be replaced around it to decrease the possibility of injury from freezing weather.

FIGURE 9.—The ethylene dichloride emulsion treatment completed. A little soil has been placed over the treated surface to prevent loss of the material.

Worming is made easier by heaping up the soil into a mound around the tree early in the summer, so as to cause the borers to enter the tree higher up than they normally would. This makes it easier to locate and remove them the following fall.

THE LESSER PEACH BORER

The lesser peach borer (*Sanninoidea pictipes* (G. & R.)) is somewhat similar to the peach borer (p. 7), but its attack occurs chiefly above ground on the trunk and limbs of the trees. The insect is invariably found working in areas on the trunk or limbs that have been injured by implements, trace chains, cankers, low temperatures, or sun scald, and in crotches or under loose bark of old trees (fig. 10).

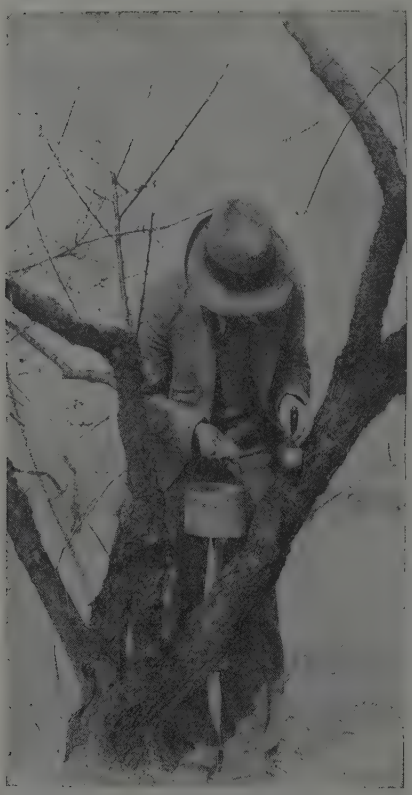

FIGURE 10.—Applying a solution of paradichlorobenzene to a tree infested with the lesser peach borer.

LIFE HISTORY AND HABITS

Like the peach borer, the lesser peach borer passes the winter in the larval stage. Early in the spring the overwintered larvae change to pupae and then to the adult moths, which deposit eggs along the trunk and limbs of the tree. A second brood of moths occurs late in summer in the South, but only one generation occurs farther north.

CONTROL OF THE LESSER PEACH BORER

The lesser peach borer may be controlled by painting the infested areas with a solution of 1 pound of paradichlorobenzene in 2 quarts of cottonseed oil (fig. 10). Crude cottonseed oil is satisfactory for this purpose and is considerably cheaper than the refined material. It is sometimes necessary to warm the cottonseed oil to dissolve the crystals. Application should be made either in the fall at about the time recommended for the application of paradichlorobenzene crystals for the peach borer, or in the spring after the weather becomes warm.

Orchardists are cautioned not to use the insecticide on any part of the tree except on well-defined infested areas. Injury may result from coating the whole trunk or limbs with the mixture, which is toxic to healthy peach tissue. The limbs or trunks should not be painted with it all the way around.

As the insect chooses for attack injured or diseased areas on the trunk and branches, care should be exercised not to scrape, bark, or otherwise injure the trees with implements while cultivating. Wounds on peach trees should be given prompt treatment, and the trees should be kept in a clean and healthy condition by proper orchard management and fertilization. Limbs broken during peach harvest or killed by low temperatures during the winter should be promptly removed. Cankers and areas killed by sun scald should be cut out before they become infested with the lesser peach borer.[3]

If a tree has become infested, worming may be practiced in the fall or spring, when all parts of the trunk and lower limbs should be examined for the larvae. In cutting out the larvae it will frequently be necessary to cut away considerable bark and rough and diseased areas. All such areas and wounds should be thoroughly cleaned out and treated with lime-sulfur or other antiseptic wash. Sprays are of little or no value for the control of the lesser peach borer.

THE SHOT-HOLE BORER

Attack by the shot-hole borer (*Scolytus rugulosus* (Ratz.)), sometimes referred to as the fruit-tree bark beetle, may be recognized by

FIGURE 11.—Peach limbs attacked by the shot-hole borer, showing gum exuding from holes made by the insect.

the presence of tiny holes in the bark about the size of small shot. These are exit and entrance holes made by the adult beetles. The branches of injured peach trees often exude quantities of gum (fig. 11)

[3] For further information on the treatment of the wounds and other injuries of trees see Farmers' Bulletin 1726, Treatment and Care of Tree Wounds.

from such holes. The shot-hole borer chiefly attacks trees that have been weakened by the attacks of other borers or scale insects, winter injury, drought, disease, unsuitable soil conditions, or mechanical injury. The insect, however, will attack healthy trees that are near severely infested ones in which the beetles have bred in large numbers.

DESCRIPTION, LIFE HISTORY, AND HABITS

In the spring the small, black beetles appear on the trees. They eat out channels between the bark and cambium layer and in these deposit their eggs. The eggs hatch after several days, and the tiny, white borers feed for about a month in burrows under the bark and then transform into the adult stage. Soon after emergence the beetles begin to deposit eggs for another generation. There are from one to four generations each year, the larger number occurring in the South. The winter is passed in the larval stage under the bark.

CONTROL OF THE SHOT-HOLE BORER

Since the shot-hole borer usually restricts its attack to weakened trees, the best means of controlling it is to do everything possible to keep the trees in a high state of vigor. This involves pruning, cultivating, and fertilizing the orchard in accordance with the best horticultural practices. The elimination of breeding quarters is also

FIGURE 12.—A thick coat of whitewash applied to a peach tree to prevent threatened attack by shot-hole borers.

important in controlling this insect. Peach trees that have been too seriously devitalized should be pulled up and burned. When only individual limbs are affected, these should be removed. Wild fruit trees and seedlings that may be furnishing breeding places for the insect near an orchard should also be removed. Prunings should not be allowed to remain on the ground in an orchard very long after they are cut, as the insect may breed in them.

Danger of attack by the shot-hole borer can be lessened by the application of a thick coat of whitewash (fig. 12). Although this has little or no effect on borers already in the trees, it has a tendency to repel the adult beetles, thus preventing the laying of eggs.

THE SAN JOSE SCALE

The San Jose scale (*Aspidiotus perniciosus* Comst.) is a pest of peach, apple, pear, plum, and other deciduous fruit trees, as well as many other plants. It takes its nourishment by sucking the sap from the trees, and in this way is directly responsible for the death of many peach trees each year.

The first indication of injury to peach trees from this scale is the killing of limbs or branches (fig. 13). An incrusted branch is readily

FIGURE 13.—Peach tree injured by the San Jose scale. Several branches have been killed.

distinguishable by its characteristic grayish appearance (fig. 14) and by the yellow, oily secretion seen when the scales are scraped off with a knife. The presence of a heavy infestation of the San Jose scale often causes a pitted, diseased condition of the wood, which may result in the exudation of droplets of gum. The feeding of the insect frequently stunts and weakens a peach tree to such an extent that it is especially subject to attacks by other pests.

FIGURE 14.—A peach twig infested with the San Jose scale. Five times natural size.

DESCRIPTION, LIFE HISTORY, AND HABITS

In most localities the San Jose scale passes the winter in a partly grown condition, resuming growth in the spring and reaching maturity early in the summer. The full-grown scale is a tiny object, about the size of a pinhead, with an ashy-gray appearance. The insect itself is a small, orange-colored, legless insect, living underneath the scale covering, which is formed chiefly from exudations from the insect. Early in the summer the young scales appear. These are very tiny, active, yellow crawlers, which move around over the tree for a few hours looking for a place to attach themselves. When a suitable place is found, the crawler sends its long threadlike beak into the tree for the purpose of sucking out the sap for food and never moves thereafter from the place of attachment. The waxy covering begins to develop over the insect as soon as it settles. Within 5 or 6 weeks after birth the females begin to reproduce. A female scale gives birth to an average of about 400 crawlers. The number of generations a season ranges from two or more in the North to six or possibly more in the South. Except during unusually cold winters, reproduction is more or less continuous in the South, and crawling young or newly settled scales may be found in the orchard at any time of the year.

The San Jose scale is preyed upon by a number of natural enemies. Important among these is the twice-stabbed ladybeetle (*Chilocorus bivulnerus* Muls.), which is usually abundant on peach trees that are heavily infested with the San Jose scale. It is jet black with two orange or red spots on the back. It takes its nourishment by sucking out the contents of the bodies of the scale insects.

CONTROL OF THE SAN JOSE SCALE

The San Jose scale may be controlled on peach by thorough spraying with either lime-sulfur or oil sprays. Since the insect does not eat the leaves or bark, the spray must be one that will produce death by direct contact. Therefore, to insure a high rate of control, a very thorough job of spraying must be done so that the spray will hit every side of the trunk, lateral limbs, and branches. The concentration of the spray necessary to produce effective scale control would cause heavy defoliation of the tree if it were used during the growing season; therefore the spraying must be done during the dormant season, when there is no foilage on the tree and when the budwood is seasoned for winter weather.

Lubricating-oil emulsions should be used at a strength of 3 percent of actual oil, and miscible oil should be used at the strength recommended on the manufacturer's label—usually from 4 to 6 percent. Lime-sulfur (32° to 33° Baumé test) should be used in the proportion of one part of the concentrate to seven parts of water.

The oil sprays are usually a little more effective than lime-sulfur; and, since they are not caustic, orchard workers are more likely to do a thorough job of spraying with them. Lime-sulfur, however, has the advantage of possessing fungicidal qualities lacked by the oils. **Lime-sulfur should never be applied in the South until after two or three killing frosts have occurred, if injury to budwood is to be avoided.**

More detailed information on these spray materials is given on pages 32 and 33.

In some areas peach leaf curl is prevalent and requires treatment. Lime-sulfur at the strength required for the control of the San Jose scale, or even at half that strength, applied during the dormant period, is effective for leaf-curl control. Oil sprays as a rule have little value for this purpose. Lubricating-oil emulsion may be combined with a 4–4–50 bordeaux mixture (4 pounds of copper sulfate and 4 pounds of lime in each 50 gallons of water) for the combined control of leaf curl and scale. Some of the miscible oils do not combine well with bordeaux mixture; the advice of the manufacturer should be sought if there is any question.

Whenever a heavy scale infestation has caused the death of limbs, they should be removed and the tree pruned, if possible, before the dormant spray is applied. Peach trees that have been devitalized by the San Jose scale should receive a fertilizer high in nitrogen the following spring to promote the growth of budwood. If an incrusted infestation of scale has stunted and greatly weakened a peach tree, it would be well to remove it during the winter and to replant.

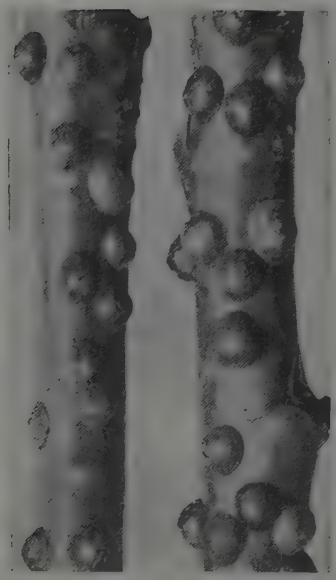

FIGURE 15.—The terrapin scale on peach twigs. About twice natural size.

THE TERRAPIN SCALE

The terrapin scale (*Lecanium nigrofasciatum* Perg.) (fig. 15) has been found on fruit trees in all the Southern States and in a number of Eastern States, although it is seldom a pest of major importance, except in the middle Appalachian region. Its presence is indicated by the sooty condition of the fruit, twigs, and leaves, caused by the growth of a black fungus on the honeydew excreted by the insect. This sooty fungus renders the fruit unsalable. The insect injures the tree in a manner similar to that of the San Jose scale, although it seldom directly causes the death of the tree. The scale covering, which resembles somewhat the shell of a terrapin, ranges in color from black to red and has a slightly ridged edge.

Lubricating-oil emulsion applied as recommended for the control of the San Jose scale but used at a 4-percent strength (12 gallons of a stock emulsion containing 66⅔ percent of oil to 188 gallons of water) is effective for the control of the terrapin scale. The emulsion should be applied during the winter while the trees are dormant. Lime-sulfur is apparently ineffective against the terrapin scale.

THE WHITE PEACH SCALE

The white peach scale (*Aulacaspis pentagona* (Targ.)), or West Indian peach scale, as it is sometimes called, has been found in a number of localities, chiefly in the South. On peach trees it is sometimes as injurious as the San Jose scale. It also attacks cherry and other stone-fruit trees. The females are circular and brownish white. The males, which are usually found in clusters, are elongated and pure white (fig. 16). There are four or five generations annually in the South.

A 3-percent strength of lubricating-oil emulsion applied during the dormant period is effective, and winter-strength lime-sulfur has also been used successfully against this insect.

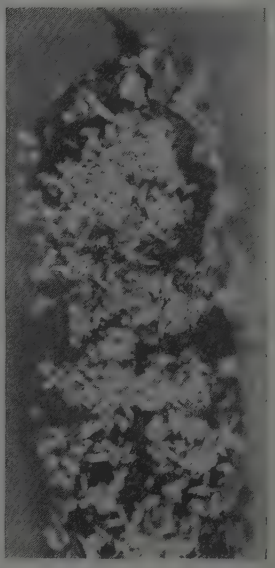

FIGURE 16.—A mass of white peach scales consisting chiefly of males. Four times natural size.

THE ORIENTAL FRUIT MOTH

The larva of the oriental fruit moth (*Grapholitha molesta* (Busck)) damages both the twigs and the fruit of the peach. The twig injury which occurs chiefly in the early part of the season, may interfere seriously with the growth of young trees, giving them a stunted bushy appearance. The injury to the fruit is somewhat similar to that caused by the larvae of the plum curculio. Many of the peaches infested by the oriental fruit moth show no external evidence of injury. Inability to cull out all the damaged peaches results in serious complaints from housewives who discover the worms.

As the name implies, this insect is believed to be of oriental origin. It was first discovered near Washington, D. C., in 1915 and has since spread to practically all peach-producing sections east of the Rocky Mountains. Its importance varies in different localities and from season to season. In the latitude of central and southern Gerogia, where very little fruit of any kind is available after midsummer, the fruit moth is rarely a serious pest because the hardened twigs, upon which the fruit moth larvae must feed in the absence of fruit, are not very suitable food for them.

FIGURE 17.—Tip of peach twig injured by the feeding of a larva of the oriental fruit moth within the twig.

LIFE HISTORY AND HABITS

The oriental fruit moth passes the winter as a larva, or "worm," in a cocoon in a crevice in the bark of the tree, in a dried-up peach, or in trash on the ground. With the first warm weather of spring, the insects undergo a transformation, and by the time of peach bloom, or a little later, the inconspicuous gray moths appear and lay their eggs, chiefly on the under side of the leaves. During the spring and early part of summer, when the new growth of peach trees is tender, the larvae enter the new twigs at the tip near the base or the axil of a leaf and eat out the center of the twig as they work downward (fig. 17). One larva may enter several twigs before it becomes mature. Heavy

infestations of the oriental fruit moth may cause a tree to take on a bushy appearance because of the growth of secondary shoots after new terminal growth is destroyed early in the season. When the twigs harden in midsummer, the larvae cease working in them and start feeding in the fruit (fig. 18). They enter the fruit either from the side near the stem, or through the stem, and injure it much as do the curculio larvae. Full-grown larvae of the fruit moth are usually pink, whereas curculio larvae are creamy white. The number of generations annually ranges from three in the New England States to six or more in south-central Georgia.

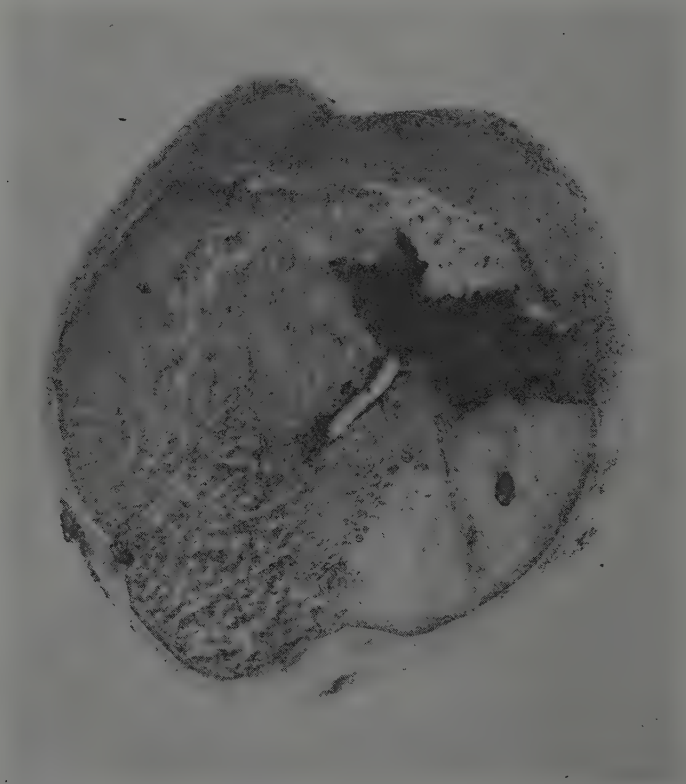

FIGURE 18.—Larva of the oriental fruit moth working in a peach.

CONTROL MEASURES FOR THE ORIENTAL FRUIT MOTH

Up to the present time no effective and practical measure has come into general use for the control of this insect. The newly hatched larva has the peculiar habit of discarding the surface layers through which it cuts in entering a twig or a fruit, and swallows little food until it has reached the inside. This means that the application of

lead arsenate, as for the plum curculio, is of little or no value. Workers at the Illinois Agricultural Experiment Station have been successful in controlling the oriental fruit moth with dusts containing 5 percent of a mineral oil, and such dusts have been used to a certain extent in Illinois and neighboring States. Their exact place in the control program, however, has not yet been established.

Experiments have been conducted by several investigators on the use of bait traps for control. A number of different fermenting sugar solutions, in many cases with the addition of aromatic chemicals, have captured large numbers of moths. Large-scale experiments carried on by the Bureau of Entomology and Plant Quarantine in northern Georgia and southern Indiana indicated that a definite reduction in fruit-moth population could be obtained by the use of bait traps. The work, however, showed that the moths travel over considerable distances, flights of a mile or two having been recorded. This means that the baiting of an individual orchard is unlikely to give much apparent benefit unless it is very well isolated or unless all orchards within a given area are baited. It is suggested that growers who are interested in trying this method of control write to their State agricultural experiment station or the United States Department of Agriculture for more detailed information.

Picking up and destroying dropped fruit infested with the larvae will reduce the infestation, and culls should be promptly removed from the sheds and buried. Paradichlorobenzene, when used for the control of the peach borer, will also kill larvae of the oriental fruit moth hibernating in cocoons on the trunks of peach trees at or near ground level. Fertilizers should not be applied late in the season, since they might promote new twig growth that would permit the insects to increase in number just before hibernation.

Because of the lack of a generally accepted insecticide for use in the control of the oriental fruit moth, the United States Department of Agriculture has given special attention to the control of this insect by its natural enemies. A detailed study has been made of native parasites that attack this pest, and a number of species have been brought in from southern Europe, Japan, and Australia. These have been propagated at the Moorestown, N. J., laboratory and, in cooperation with various State agencies, have been colonized in practically all the more important peach-producing areas in the United States where the fruit moth is a problem. In many cases the results have been very favorable, and the damage by this insect has been very much reduced. In some areas, however, conditions have not been so favorable for the parasites, and they have been of much less benefit. The most valuable of these species has turned out to be one known as *Macrocentrus ancylivorus* Roh., which is native to the United States, and this species has predominated in the releases made by the Department.

The plan followed in this work has been to establish as many species as possible in all the leading areas where conditions permit. After the parasites are once established, it is expected that they will naturally increase within a few years to the numbers which local climatic conditions will allow and that they will spread to other orchards within the general area by means of their own flight. A few State agencies have been in position to intensify this distribution and have been able to liberate the parasites in many more orchards than could be covered by the United States Department of Agriculture.

THE PEACH TWIG BORER

The peach twig borer (*Anarsia lineatella* Zell.) occurs generally throughout the peach-growing areas of the United States, but it seldom does much damage in the Eastern States. The larva, or "worm," injures the twigs and fruit of peach trees in much the same manner as does the oriental fruit moth (fig. 17). The confusion arising from the similarity of the damage done by these two insects has at times caused alarm. Occasionally the damage done to the twig by the peach twig borer is rather heavy and stops the growth of, or kills shoots early in the spring.

The life history of the peach twig borer is similar in some respects to that of the oriental fruit moth. The borer passes the winter as a partly grown larva in a silk-lined cavity under loose bark, in crotches, in cavities in the trunk, and in similar places. The larva emerges in the spring and attacks the new tender shoots, which soon wilt and die. The mature larva is reddish brown or chocolate in color and may thus be distinguished from the larva of the oriental fruit moth, which is usually pinkish. There are from one to four or more generations annually, the larger number occurring in the South.

CONTROL MEASURES FOR THE PEACH TWIG BORER

Spraying, just as the buds show pink, with either lime-sulfur solution in the proportion of 1 part of the concentrate to 10 parts of water or lead arsenate in the proportion of 1½ pounds of powder to 50 gallons of water has been recommended for the control of the peach twig borer. Burning the brush removed during the winter pruning will lessen injury.

SUCKING BUGS

Considerable scarring and distortion of peach fruit is caused by several species of sucking bugs that feed on peaches in different parts of the country. Under some conditions the losses are rather serious. Most of the injury is done when the peaches are very small, and the subsequent distortion of the fruit is out of proportion to the feeding that has actually been done. A few of the more important insects involved in this type of injury will be discussed.

Two of the so-called leaf-footed bugs (*Leptoglossus oppositus* (Say) and *L. phyllopus* (L.)) very frequently cause injury of this kind (fig. 19) in the South. Their feeding occurs chiefly in the spring, although they may be on the peach trees throughout the season. These are long, narrow bugs, and their long hind legs have flattened enlargements, which suggest tiny leaves.

The green stinkbug (*Acrosternum hilaris* (Say)) and the southern green stinkbug (*Nezara viridula* (L.)) sometimes cause serious damage to peaches in certain localities. The adults feed on the fruit early in the season; and later the nymphs, or young bugs, also cause some injury. These species are among the largest of our native stinkbugs. Both forms are green, although in the case of the southern green stinkbug there is sometimes a slight pinkish tinge.

Several species of large gray-to-brown stinkbugs (*Euschistus* spp.) have been found to cause more or less injury to peaches in the Central West and probably cause some damage in other areas. Their feeding on peaches occurs almost entirely very early in the season, and they

are found on weeds or cover crops in or close to the orchard the rest of the year.

The tarnished plant bug (*Lygus pratensis oblineatus* (Say)) occurs throughout the United States, and in the Central West has in some seasons been an important cause of deformed peaches. This species hibernates in the adult stage, and in the early spring finds the buds, blossoms, and newly formed young peaches the most attractive food available. In feeding they appear to inject a poisonous secre-

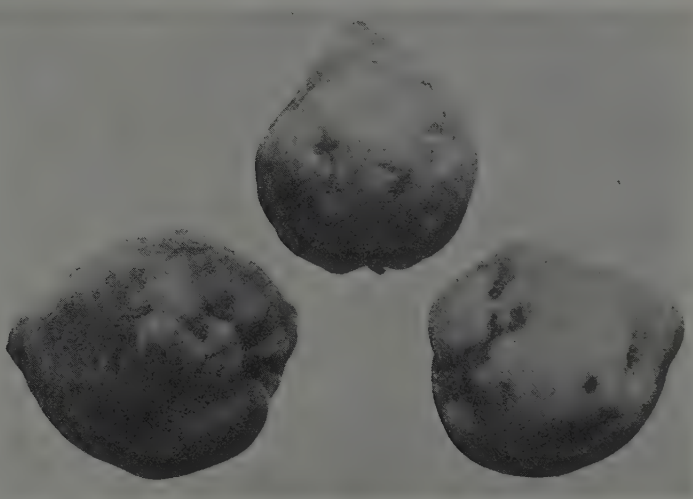

FIGURE 19.—Ripe Hiley peaches showing the effect of attack by leaf-footed bugs several months before.

tion, which causes rather extensive breaking down of the tissue of the young peaches. The most seriously injured peaches drop. Others remain on the tree, but the affected areas later scar over and produce extensive distortion.

CONTROL OF SUCKING BUGS

The control of this group of insects is an extremely difficult matter. This is particularly true of the gray or brown stinkbugs and tarnished plant bugs, which live and breed chiefly on weeds and cover crops in or near the orchard and are found on the trees only for a short period early in the spring. At that time they are full-grown adults and are very resistant to the ordinary contact sprays. Efforts to control them by the application of insecticides have therefore been unsuccessful. The most effective means of dealing with them is to eliminate such cover crops as sweetclover and alfalfa from the orchard and its vicinity and to reduce as far as possible the amount of weed growth in the orchard. For the leaf-footed bugs and green stinkbugs, which breed to a certain extent on the peach trees, the use of a contact spray, such as nicotine sulfate, in the proportion of 1 quart to 100 gallons of water with the addition of a small amount of soap, will control the insect in its younger stages.

APHIDS

A number of species of aphids, or plant lice, are found on peach trees, feeding on the foliage or young shoots and in certain cases on the roots. Ordinarily these do not become abundant enough to require control measures, although occasionally serious damage is done. Three of the more important species will be discussed briefly.

The rusty plum aphid (*Hysteroneura setariae* (Thos.)) frequently damages the foliage of plum and young peach trees shortly after they put forth leaves, causing the new foliage to become distorted and crumpled by sucking out the food material. The pest may cause the terminal buds of the plum and young peach trees to become so stunted that growth ceases. A heavy infestation may kill the blossoms and prevent fruit from setting. These aphids are most common in home orchards that are not sprayed for other pests in the spring. The eggs, which are deposited on the small twigs in the fall, begin hatching about the time the buds open. The first few broods are wingless, but winged forms are produced later. These migrate to several varieties of grasses and there breed the rest of the summer. As cold weather approaches in the fall, winged forms return to the plum and young peach trees.

The black peach aphid (*Anuraphis persicae-niger* (Smith)) attacks the twigs, shoots, and roots of peach trees and is often seriously abundant in the Middle Atlantic States. Some of the insects live throughout the year on the roots of the peach; others, however, migrate from the roots late in winter or early in the spring and start colonies on twigs and young shoots. Serious damage sometimes occurs to young orchard trees or to nursery stock.

The green peach aphid (*Myzus persicae* (Sulz.)) is a widely distributed species which occasionally becomes abundant on peach trees, although it has been of greater importance as a pest of other crops. As with the rusty plum aphid, the feeding on peach trees occurs chiefly in the spring or very early in the summer, and the species migrates to other food plants for most of the summer.

CONTROL OF APHIDS

The rusty plum aphid and green peach aphid may be controlled by spraying the trees with three-fourths of a pint of nicotine sulfate in 100 gallons of water to which about 3 pounds of soap have been added. To be fully effective, this spray should be applied early in the season when the aphids first appear and before they have curled the leaves. The black peach aphid, which winters on the roots of the tree, may appear above ground at any time. In districts where difficulty has been experienced with this insect, careful watch should be maintained and an application of nicotine sulfate and soap made as soon as the insects appear. After the leaves have been curled, control is very difficult, if not impossible.

SPRAYING AND DUSTING OUTFITS

For spraying a few peach trees around the home or in a small home orchard, a bucket spray pump may be used. This should be made of brass or some other metal that will not corrode. A good type of bucket spray pump is shown in figure 20. It should be equipped with a 4-foot extension rod and at least 15 feet of hose.

FIGURE 20.—Bucket pump for spraying a few trees. This outfit should be equipped with a 4-foot extension rod and at least 15 feet of hose.

The wheelbarrow sprayer is a convenient type for the home orchardist. The capacity is usually from 12 to 15 gallons, and it can be used for spraying a small home orchard if equipped with a 4-foot extension rod and 25 feet of hose.

For spraying orchards of 400 or 500 trees, a barrel spray pump (fig. 21) can be used. This pump fits into a 50-gallon barrel and

FIGURE 21.—A barrel pump. This pump fits into a 50-gallon barrel and develops from 125 to 150 pounds' pressure At least 25 feet of hose should be provided, so that all parts of a tree can be reached.

develops from 125 to 150 pounds' pressure. It should be equipped with a 4-foot extension rod and at least 25 feet of hose.

An "estate" sprayer with 50-gallon tank and powered by a small gasoline engine to develop as much as 300 pounds' pressure can be used for spraying peach orchards of from 5 to 10 acres. This type of outfit should be equipped with a 4-foot extension rod and from 35 to 50 feet of hose.

The standard power-spray outfit (fig. 22) is the most satisfactory,

FIGURE 22.—Power sprayer in operation. This type of equipment is needed for orchards of 10 acres or more.

useful, and convenient type of sprayer. It may be purchased in various sizes and should be used in peach orchards of 10 or more acres. It will develop 300 pounds' pressure or more, depending on the power of the motor, and will deliver from 10 to 20 or more gallons of spray per minute. It is usually equipped with a spray tank holding from 200 to 300 gallons, and two leads of hose 50 feet long should be provided.

For dusting a few peach trees a hand duster consisting of a cylinder with piston rod for making an air blast may be used. Larger hand dusters in which a fan is operated by cogs or belt from a crank will be found more satisfactory and durable for dusting a few trees or a very small home orchard by hand.

For dusting commercial or large home orchards a power-duster outfit should be employed. These outfits are driven by a 3- or 4-horse-power gasoline engine and can be regulated to discharge the desired quantity of dust.

INSECTICIDES

LEAD ARSENATE

Lead arsenate is the standard insecticide for chewing insects, such as the plum curculio. It may be purchased in either the powder or the paste form, but the powder is more generally used. Lead arsenate is normally a white substance, but as a safety measure it has in recent

years been colored pink. The lead arsenate available commercially in the Eastern States is known chemically as acid lead arsenate. On peach trees powdered lead arsenate is ordinarily used at a strength of 2 pounds to 100 gallons of water (3 rounded teaspoonfuls per gallon). It should be made into a thin paste with water before it is added to the water in the spray tank.

Lead arsenate, when applied on peach trees, sometimes causes severe injury to the leaves, twigs, and fruit. This may be prevented in part by the addition of 8 pounds of hydrated lime to each 100 gallons of spray. A very finely divided high-calcium lime, often called chemical hydrated lime, is now available for use in spraying.

A more effective way of preventing arsenical injury is by adding zinc sulfate to sprays containing lead arsenate and lime or lead arsenate, lime, and wettable sulfur. The mixture of zinc sulfate and lime is referred to as zinc-lime, and is discussed in more detail in the following section. Zinc-lime is used by a great many commercial growers, but for the home orchardist the use of lime to prevent arsenical injury is undoubtedly more convenient. **Zinc sulfate should never be used without an equal quantity of lime.** Self-boiled lime-sulfur is also of value in preventing injury to foliage by lead arsenate; and, when this fungicide is used, zinc-lime is not usually added.

WARNING.—Lead arsenate is a deadly poison and should be stored and handled in such a way that children and domestic animals cannot gain access to it. Workmen who are using this poison should avoid getting it into their mouths or breathing dusts containing it.

ZINC-LIME [4]

The following formula is recommended for the zinc-lime spray where peach diseases are to be controlled:

Zinc sulfate	pounds	8
Hydrated lime (fresh)	do	8
Water	gallons	100

The proportions of zinc sulfate and hydrated lime to water may be increased up to 16–16–100 if desired, without causing injury, but proportionately better results have not followed the use of a zinc-lime spray stronger than the one here recommended. When used solely for the purpose of preventing arsenical injury, a zinc-lime spray containing 2 pounds of zinc sulfate per 100 gallons will give good results.

Zinc sulfate ($ZnSO_4.7H_2O$), sometimes called granular zinc sulfate or white vitriol, is a common chemical easily obtained through wholesalers and jobbers. A so-called anhydrous zinc sulfate is sometimes found on the market. This product is not anhydrous (free from water) but contains, in varying quantities, less water than the granular zinc sulfate and is more easily handled because it is relatively free from lumps. For practical purposes, 3 pounds of the so-called anhydrous zinc sulfate may be considered equal to 4 pounds of the ordinary granular zinc sulfate, provided it has been stored in a dry place and kept well covered so that it has not absorbed water. Zinc sulfate may be obtained in a flake as well as in a crystalline form.

[4] Most of the information on zinc-lime in this section was taken from Farmers' Bulletin 1527, Peach Brown Rot and Scab, pp. 14–15, revision of October 1936.

To prepare the spray, fill the tank nearly full of water. Start the engine to agitate the spray materials. Add zinc sulfate, which, if the lumps are well broken up, will dissolve in less than 5 minutes. After it has dissolved, wash the lime, mixed with a small quantity of water to form a thin paste, through the strainer into the tank. Finish filling the tank and agitate for 5 minutes or more before beginning to spray. The white precipitate settles somewhat rapidly when there is no agitation, but it is easily kept in suspension by agitation. Use the spray at once.

Zinc-lime is the safest and most effective spray developed for the control of peach bacterial spot caused by *Bacterium pruni* E. F. S. Six or seven applications at 2-week intervals, beginning at petal fall, are necessary.

OIL SPRAYS

Oil sprays are used for the control of the San Jose scale and other scale insects. They are available as miscible oils and as lubricating-oil emulsions. The stock lubricating-oil emulsions are white to creamy in appearance and vary in consistency from that of thin cream to a stiff pasty mixture resembling mayonnaise. The lubricating-oil emulsion stock may be bought in prepared form or may be made on the farm.[5] The oil content of the lubricating-oil stock emulsions ranges from 50 to 90 percent, the most commonly used formulas giving mixtures that contain approximately 67 percent of actual oil. Table 4 is given for the convenience of the reader in working out the proper strength of oil sprays.

TABLE 4.—*Dilution table showing the number of gallons of stock of a lubricating-oil emulsion of any given strength that must be used in enough water to make 100 gallons of a spray mixture of 1, 2, 3, or 4 percent of oil*

	Quantity of stock[1] needed to obtain given percentages of oil in 100 gallons of diluted material					Quantity of stock[1] needed to obtain given percentages of oil in 100 gallons of diluted material			
	1 percent	2 percent	3 percent	4 percent		1 percent	2 percent	3 percent	4 percent
Oil content of stock material (percent):	*Gallons*	*Gallons*	*Gallons*	*Gallons*	Oil content of stock material (percent)—Cont.	*Gallons*	*Gallons*	*Gallons*	*Gallons*
50	2	4	6	8	75	1½	2¾	4	5½
55	2	3¼	5½	7½	80	1¼	2½	3¾	5
60	1¾	3½	5	6¾	85	1¼	2½	3¾	4¾
65	1¾	3¼	4¾	6¼	90	1¼	2¼	3½	4½
70	1½	3	4½	5¾					

[1] Fractions rounded off in each case to next higher one-fourth gallon.

A miscible oil is usually clear, like an ordinary lubricating oil, but contains an emulsifier that causes it to mix readily with water. Miscible oils should be diluted and used in accordance with the manufacturer's directions found on the label of the container.

[5] Formulas and directions for the preparation of oil sprays may be found in Farmers' Bulletin 1676, Lubricating-Oil Sprays for Use on Dormant Fruit Trees.

LIME-SULFUR

Lime-sulfur is an old remedy for the San Jose scale, which is also used for the control of the white peach scale and the peach twig borer. The solution can be purchased from manufacturers or can be made on the farm.[6] The concentrate should test 32° or 33° Baumé, and should be used in the proportion of 1 part to 7 parts of water for scale control and in the proportion of 1 to 10 for peach twig borer control.

Lime-sulfur may also be purchased in the dry form, in which case it should be used in accordance with the manufacturer's directions.

PARADICHLOROBENZENE

Paradichlorobenzene is used chiefly for the control of the peach borer. It is a white crystalline material, insoluble in water, with a characteristic odor irritating to the mucous membrane of the nose. Crystals of about the fineness of granulated sugar or small, thin, flaky crystals have been found most satisfactory for peach borer control. They vaporize slowly at ordinary temperatures, and the vapor is somewhat heavier than air. The gas is deadly to insects confined in it, but as used is not poisonous to man or domestic animals. Orchardists are strongly advised to use only unadulaterated paradichlorobenzene and (when ordering) to specify a grade of about the fineness of granulated sugar, or small, thin, flaky crystals. Successful results cannot be assured with the use of a compound containing only part paradichlorobenzene and part inert material, since there can be no certainty of the quantity of the chemical present around the tree.

ETHYLENE DICHLORIDE

Ethylene dichloride is a colorless liquid with an odor like that of chloroform. It is heavier than water and vaporizes freely at ordinary temperatures. The vapor is heavier than air and penetrates the soil readily. The chemical is only very slightly soluble in water and burns with difficulty when ignited by a lighted match. When the vapor of ethylene dichloride is inhaled, it has an anaesthetic action, although one that is less rapid than that of chloroform. Unless breathed in high concentrations over a protracted period of time, no harmful results need be feared in working with this compound. Long-continued contact with ethylene dichloride has been reported to cause some skin irritation, and due care should be taken by those who have occasion to work with this material for long periods of time.

Commercially prepared emulsions are available on the market, and the packages bear directions for dilution and use. It is also possible to prepare the emulsion at home.

Ethylene-dichloride stock emulsion is prepared from the following ingredients:

	Parts (by volume)
Potash fish-oil soap	1
Water	8
Ethylene dichloride	9

[6] See Farmers' Bulletin No. 1285, Lime-Sulphur Concentrate, Preparation, Uses, and Designs for Plants.

Since the compound boils at temperatures below the boiling point of water, heat should not be employed in making this emulsion, and the liquid should be kept away from fire and open-flame lights. It is desirable that the air temperature be between 50° and 80° F. To avoid the breathing of undue concentrations of the vapor, the emulsion should be prepared outdoors or in a well-ventilated room.

A good grade of potash fish-oil soap should be used; that is, one without an excess of caustic potash and with approximately 30 percent of actual soap and 70 percent of water. The soap should first be put into the mixing vessel and the water added slowly while the materials are stirred, until the soap is well dissolved. The ethylene dichloride should then be added and emulsified cold by pumping the mixture into another container.

The stock emulsion may also be made by stirring. By this method the soap is first placed in the mixing container and the ethylene dichloride added slowly, a little at a time, with constant stirring. When the soap and ethylene dichloride are thoroughly mixed, the water is added slowly with constant stirring.

The stock emulsion made by either method contains 50 percent of ethylene dichloride; it is further diluted with water just before it is used, the amount of dilution depending on the age of the tree and the dosage required. (See table 3, p. 13).

If the stock emulsion breaks down after being prepared, there is formed a curdled mass or a layer of clear ethylene dichloride on the bottom that cannot be readily remixed by moderate agitation. The material must then be reemulsified by pumping the mixture from one container to another or back into the same container, or by starting over again with a small quantity of potash fish-oil soap to which small quantities of the broken emulsion are added slowly at intervals with constant stirring.

NICOTINE SULFATE

Nicotine sulfate is frequently employed for the control of soft-bodied sucking insects, such as aphids. The form usually available on the market is a solution of the sulfate containing the equivalent of 40 percent of nicotine itself. For most effective results, it should be used with some alkaline material, such as lime, or with soap in order to liberate the nicotine. Soap also assists in wetting the bodies of the insects, thus improving the control obtained.

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